



# **Duke Farms Floodplain Reforestation Project**

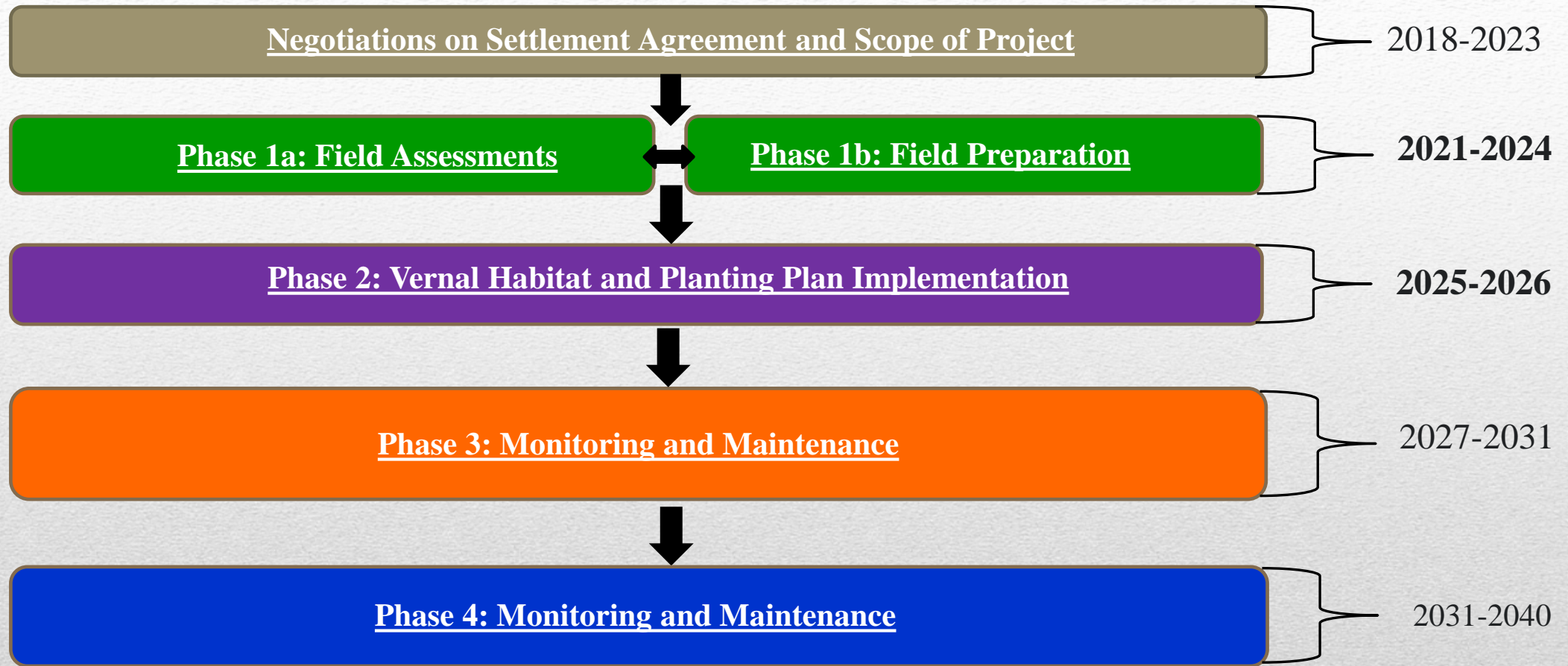
**April 16, 2025**



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- Project Timeline for Reforestation Mitigation and Compensation (2018-2040)
- Duke Farms: the Optimal Compensation Site
- Phase 1a: Field Locations and Assessments
- Phase 1b: Field Preparations
- Phase 2a: Wetland Design
- Phase 2b: Wetland Construction Planning and Metrics
- Phase 2: Projected Outcomes
- Duke Farms Supporting Initiatives
- Questions



Determining what is feasible for the proposed ecological uplift is an essential parameter in selecting a site for restoration. The most effective enhancement activities are the removal of invasive species and the planting of native plants, which results in:

- increasing plant biodiversity
- connecting wildlife corridors
- creating and diversifying wildlife habitat,
- decelerating and absorbing floodwaters and magnifying the retention of floodwater sediment onto the floodplain
- removing excess nutrients from river water

WET/Highway Method Shared Function/Value	Starting Baseline	Compensatory Uplift
Groundwater Recharge	LOW Secondary Function	MODERATE Secondary Function
Groundwater Discharge	LOW Secondary Function	MODERATE Secondary Function
Flood Flow Alteration	LOW Secondary Function	HIGH Secondary Function
Fish & Shellfish Habitat	NA	NA
Sediment/Toxicant Retention	MODERATE Secondary Function	HIGH Secondary Function
Nutrient Removal	MODERATE Secondary Function	HIGH Secondary Function
Production Export	LOW Secondary Function	HIGH Secondary Function
Sediment/Shoreline Stabilization	LOW/MODERATE Secondary Function	HIGH Secondary Function
Recreation	MODERATE Primary Function	HIGH Primary Function
Wildlife Habitat	LOW Primary Function	MODERATE Primary Function

Why Duke Farms was the Optimal Compensation Site

17.8-acre mitigation area (i.e., pilot study)

Field 36 6.1 acres

Field 38 43.58 acres

Field 39 56.1 acres

Field 40

Field 41 8.18 acres

Fields with the yellow border are the 112 acres of the floodplain reforestation project

# Duke Farms Project Field Acreage



**Field 36**



**Field 38**



**Field 39**



**Field 40**

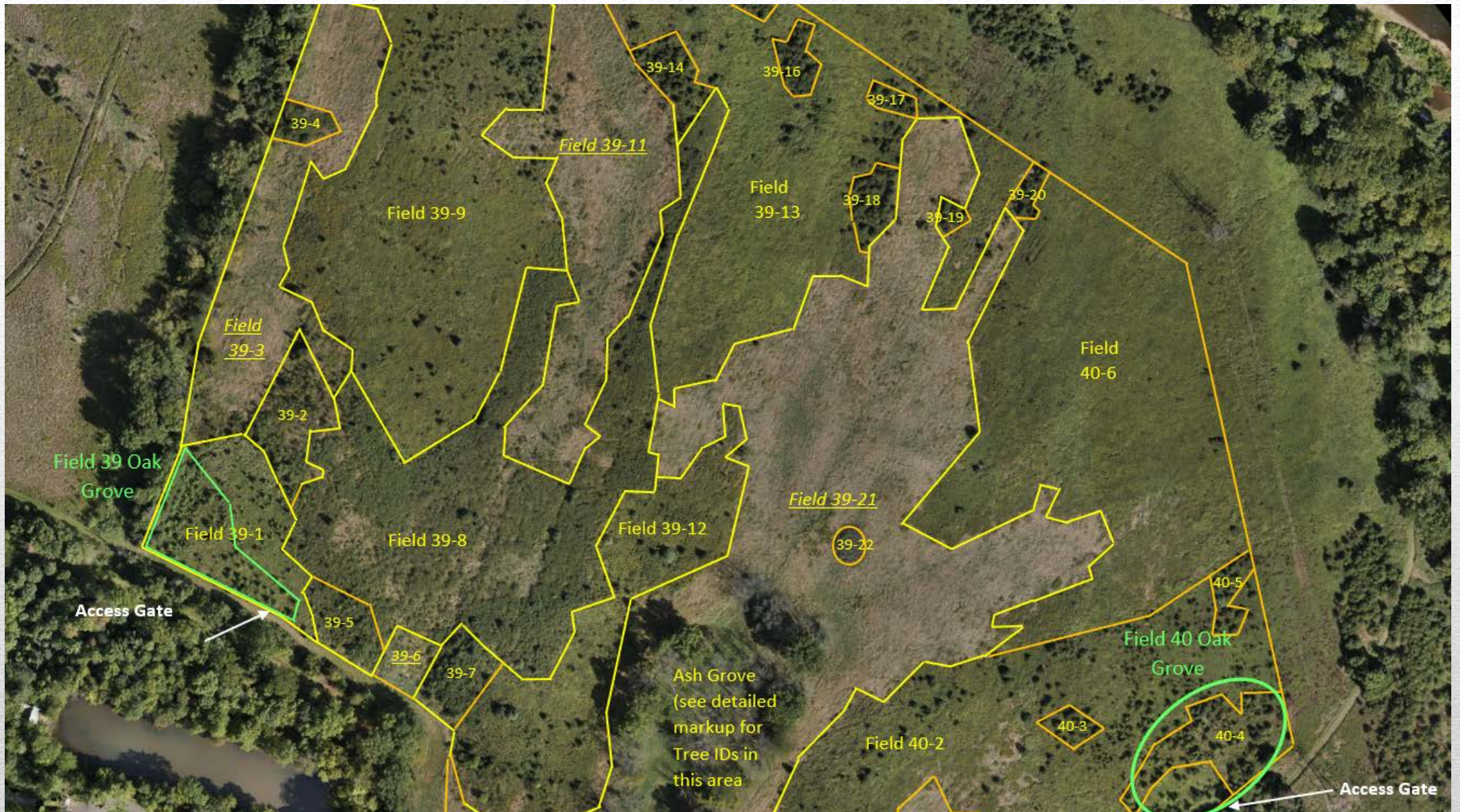


**Field 41**

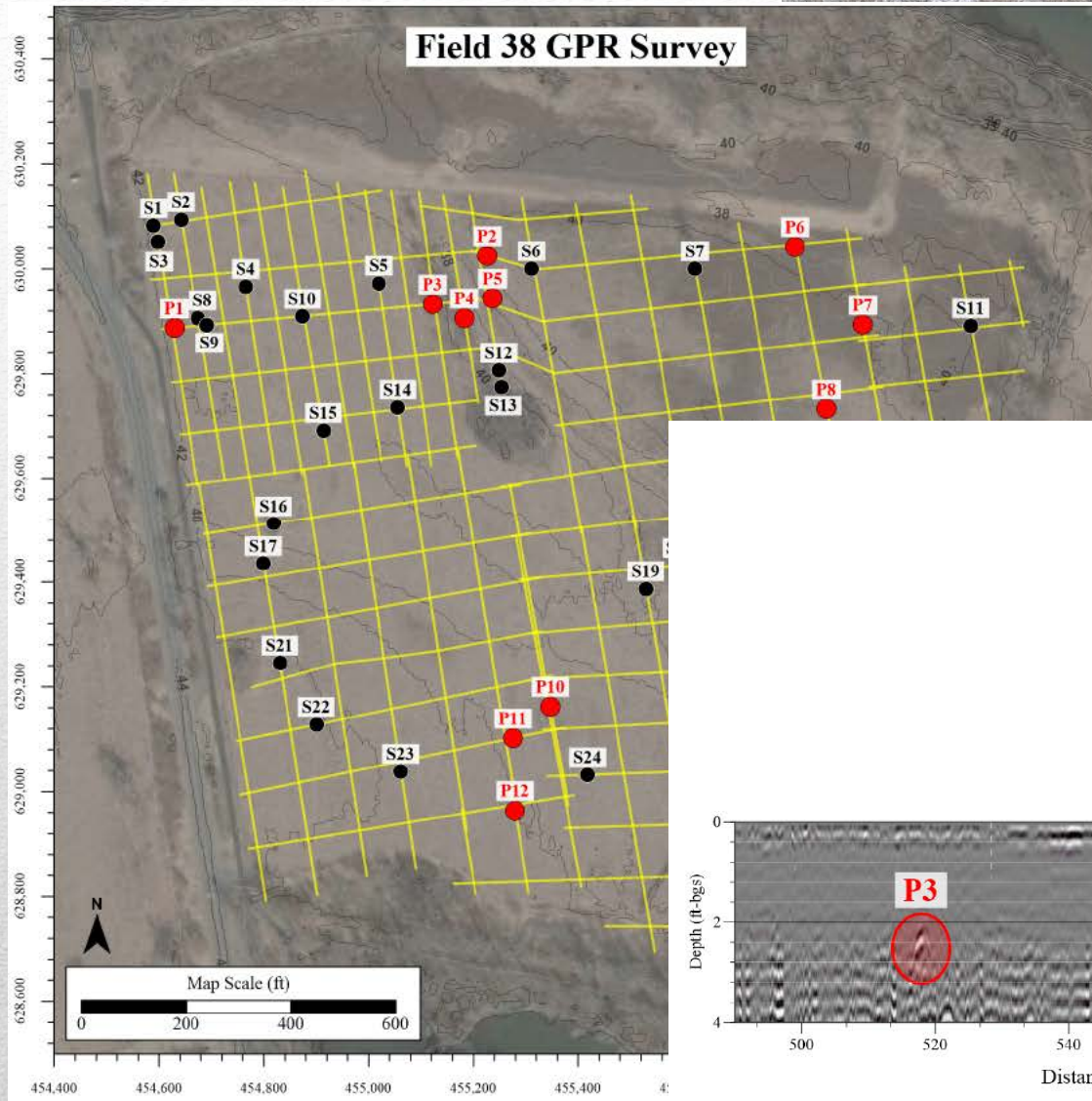
## Phase 1a: Field Assessment

## A Science-Based Approach

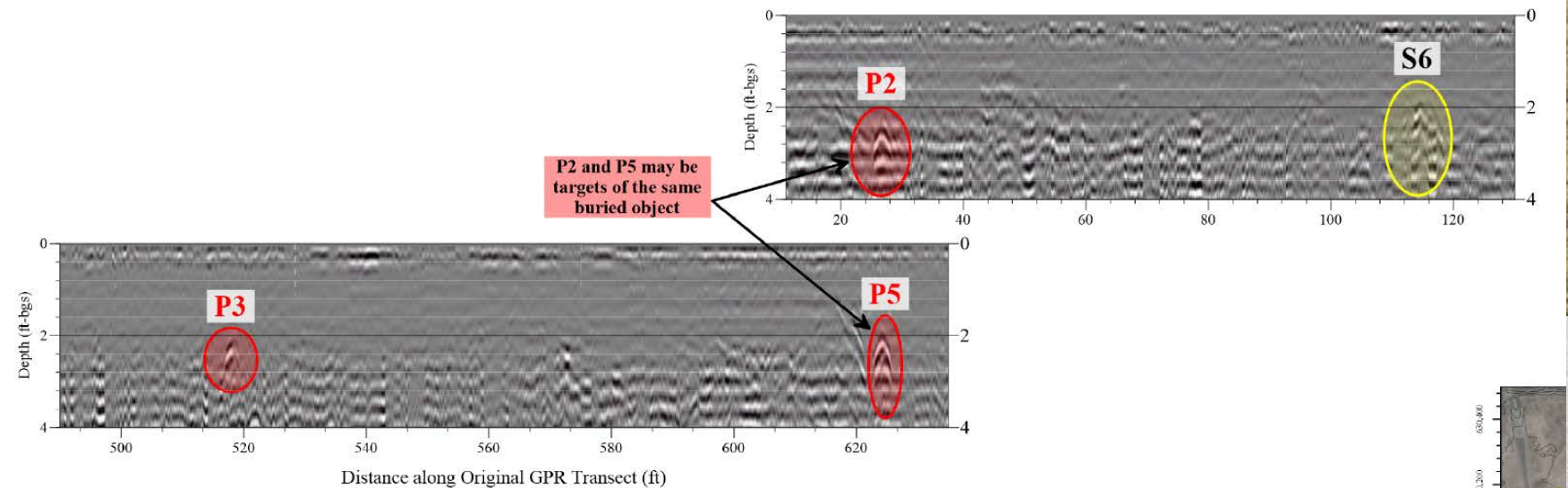
- Vegetation Coverage and Topographic Surveys via Drone
- Ground Penetrating Radar (GPR) Survey for Drainage Tiles
- Well Point Piezometer Installation & Continuous Water Level Gauging
- Soil Sampling and Lithology Description
- Soil Vertical Permeability Testing



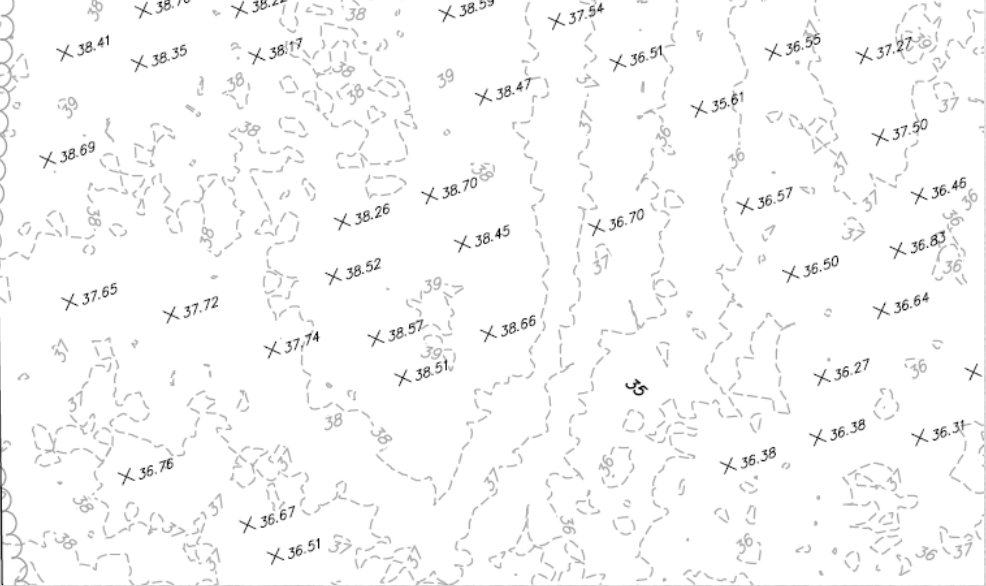
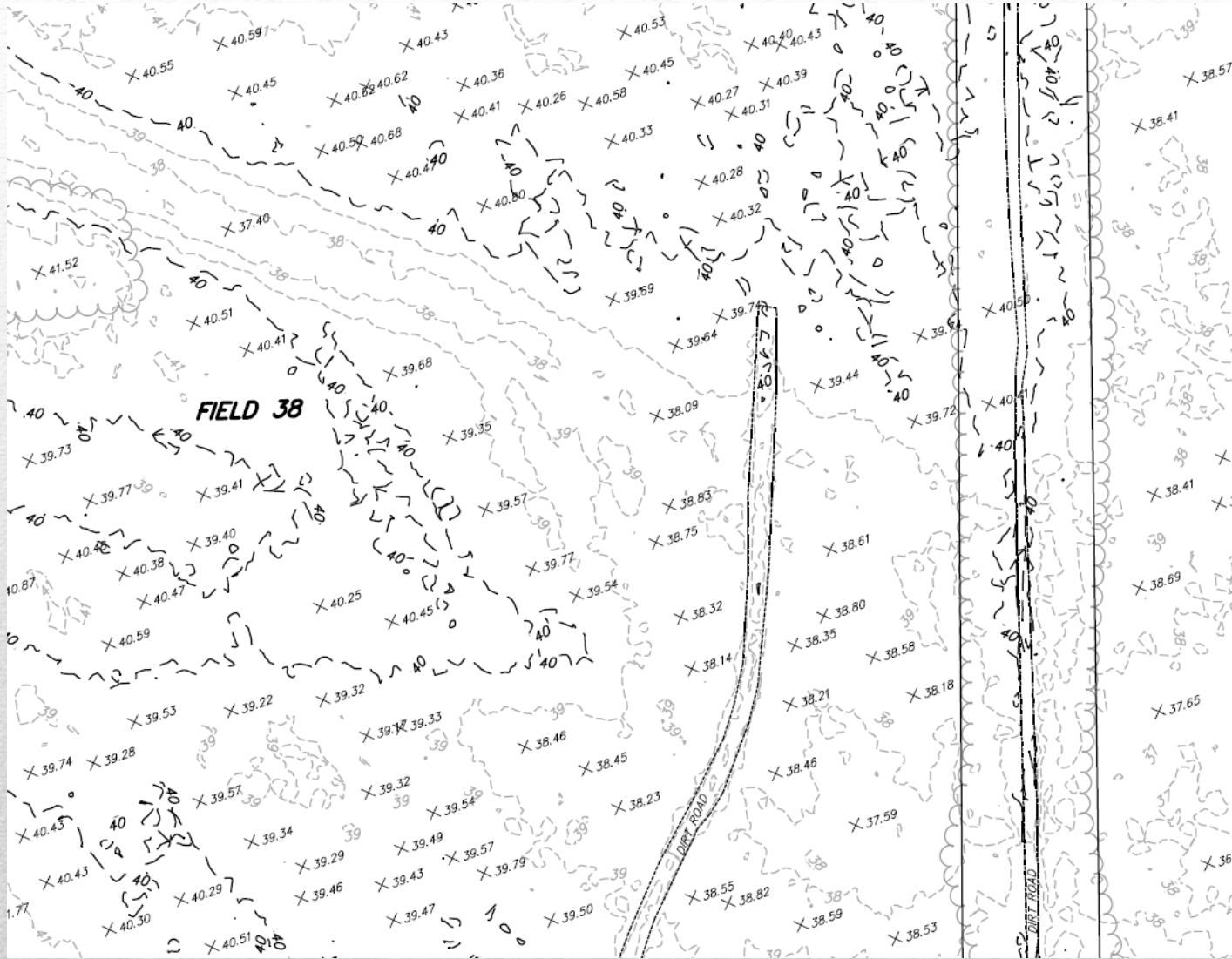
## Phase 1a: Field Subdivisions to Scope Invasive Species Treatments



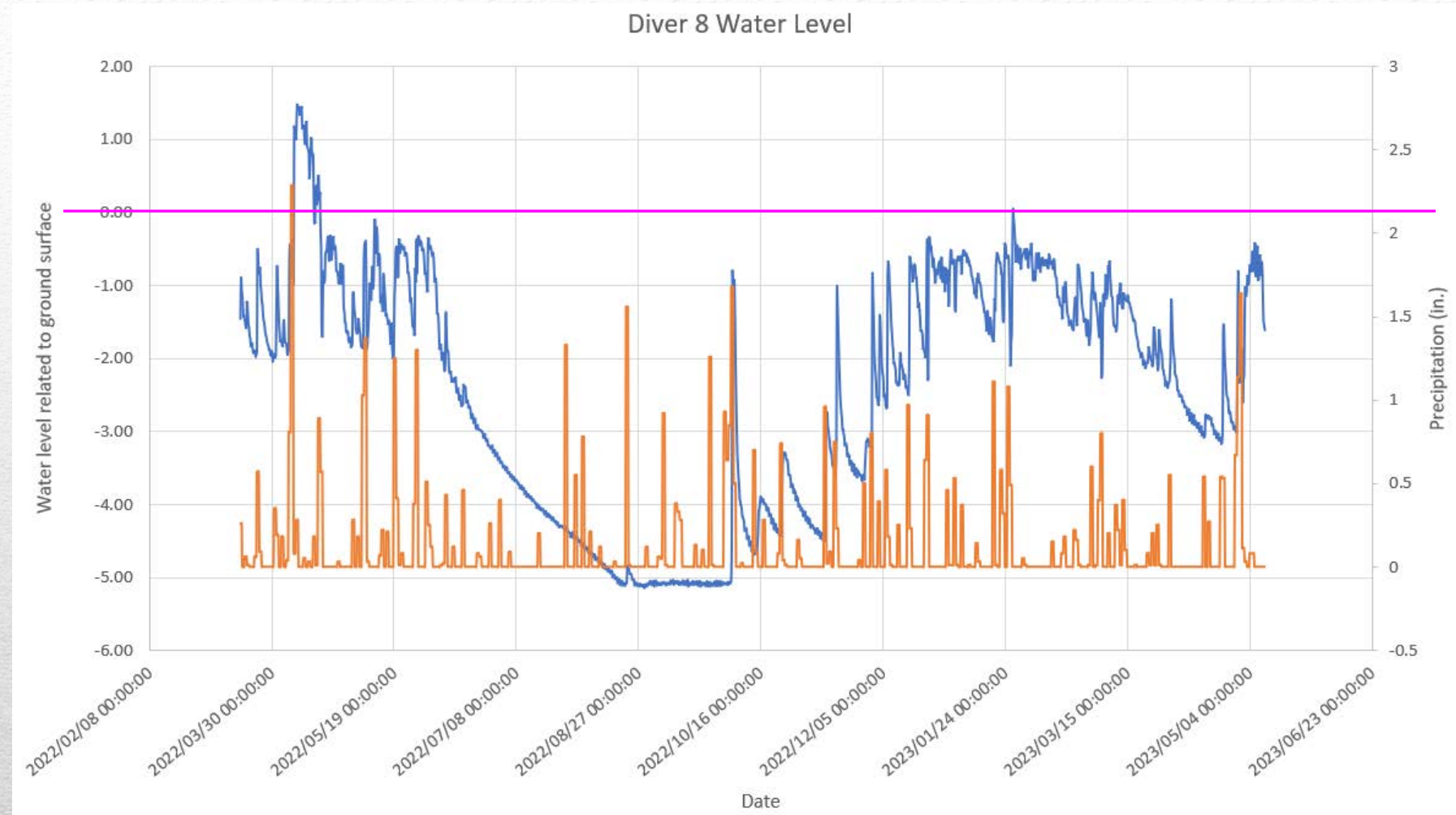
**Stantec Duke Farms Field 38 GPR Survey  
Example Primary and Secondary GPR Transects**










Phase 1a: GPR Survey to Locate Possible Intact Drainage Tiles and Pipes



## Phase 1a: Drone Survey Microtopography Mapping



PROJECT: <b>Duke Farms Wetland Soil Permeability Invest.</b> LOCATION: <b>Duke Farms, Hillsborough Twp, New Jersey</b> PROJECT NUMBER: <b>195620013</b>		WELL / PROBEHOLE / BOREHOLE NO: PAGE 1 OF 1 <b>DDF-F39-SB4</b>		
DRILLING:     STARTED <b>4/19/23</b> COMPLETED: <b>4/19/23</b> DRILLING TIME:     STARTED <b>8:16</b> COMPLETED:		*NORTHING (ft): <b>628528</b> *EASTING (ft): <b>456572</b> *GROUND ELEV (ft): <b>35.69</b> *TOC ELEV (ft):		
DRILLING COMPANY: <b>East Coast Drilling, Inc. (ECDI)</b> DRILLING EQUIPMENT: <b>Manual Slide Hammer</b>		INITIAL DTW (ft): <b>2.4</b> BOREHOLE DEPTH (ft): <b>6.7</b> STATIC DTW (ft): <b>Not Measured</b> WELL DEPTH (ft):		
DRILLING METHOD: <b>Macro Core Soil Sampler</b>		WELL CASING DIAMETER (in): ---     BOREHOLE DIAMETER (in): LOGGED BY: <b>J. Jengo PG/LSRP</b> CHECKED BY:		
SAMPLING EQUIPMENT: <b>1.75" OD x 1.68" ID Acetate Liners</b>		*COORDINATE SYSTEM AND DATUMS: NJ STATE PLANE SOUTH, NAD83, NAVD 88		

Depth (feet)	Graphic Log	USCS	Description	Sample	Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)	Depth (feet)
1		CL	CL; LEAN CLAY, >50% Silt, trace sand, 5YR 3/3 (dark reddish brown), medium plasticity, low dry strength, firm, dry						
2		ML	ML; SILT, Clay, trace sand, 5YR 3/3 (dark reddish brown), medium plasticity, medium dry strength, firm, dry to moist						
3		CH	CH; FAT CLAY, >50% Silt, trace sand, 5YR 3/2 (dark reddish brown), high plasticity, medium dry, strength, soft, moist						
4		CH	CH; FAT CLAY, >50% Silt, trace sand, 5YR 4/4 (reddish brown), high plasticity, medium dry strength, soft, wet						
5									
6		SM	SM; SILTY SAND with GRAVEL, trace clay, 5YR 3/1 (very dark gray), non-plastic, no dry strength, loose, wet, increasing gravel content (<= 1 inch in diameter) below 6.4' below ground surface						
7			End of boring 6.7'						



# Phase 1a: Soil Boring and Permeability Testing

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	2.4044	2.2954	2.2868	Chamber	35
Diameter (in.)	2.7570		2.8138	Influent	30.2
Moisture Content (%)	25.5		24.6	Effluent	30
Dry Unit Weight (pcf)	99.3		100.3	Applied Head Difference (psi)	
Void Ratio	0.710		0.694	Back Pressure Saturated to (psi)	
Degree of Saturation (%)	97.9		96.5	Maximum Effective Consolidation Stress (psi)	
				Minimum Effective Consolidation Stress (psi)	

						Hydraulic Conductivity			
Date	Clock (24H:M)	Temp. (°F)	Bottom Head (in)	Top Head (in)	Test Time (sec)	k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
11-7-23	8:47	72.0	21.35	4.33	0	---	---	---	---
11-7-23	8:53	72.0	21.11	4.56	3.60E+02	5.4E-08	5.4E-06	5.1E-08	5.1E-06
11-7-23	8:59	72.0	20.87	4.79	3.60E+02	5.5E-08	5.5E-06	5.2E-08	5.2E-06
11-7-23	9:05	72.0	20.63	5.02	3.60E+02	5.6E-08	5.6E-06	5.3E-08	5.3E-06
11-7-23	9:11	72.0	20.41	5.25	3.60E+02	5.5E-08	5.5E-06	5.2E-08	5.2E-06

## Phase 1a: Soil Boring and Permeability Testing



Phase 1b: Field Marking of Desirable Trees to Retain



Phase 1b: Field Preparation – Herbicide Spraying



Phase 1b: Field Preparation – Invasive Tree Cutting



Phase 1b: Field Preparation – Woody Debris Stockpiling for Off-Site



Phase 1b: Field Preparation – Perimeter Fence Line Surveying



Phase 1b: Field Preparation – 2024 Activities – 2<sup>nd</sup> Invasive Treatments



GEOLOGICAL SURVEY OF NEW JERSEY.

## FINAL REPORT

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1889.

*A. saccharinum*, L. (*A. dasycarpum*, Ehrh.) Silver Maple.

Sussex: Waterloo and along the Delaware River—Britton.  
Warren: Very abundant from above the Water Gap to Riegelsville—Porter. Hunterdon: Common along the Delaware—Best.

*A. rubrum*, L. Red Maple. Swamp Maple.

Swamps and low grounds. Common throughout the State.

QUERCUS, L.

Oak.

*Q. alba*, L. White Oak.

Woods. Common throughout the State. Not abundant in the pine barrens. A form with peculiarly lengthened leaves at Bridgeton—J. B. Potter.\*

*Q. minor* (Marsh.), Sargent. (*Q. obtusiloba*, Michx.) Post Oak.

In sandy or rocky woods. Bergen:—Austin. Hudson: On Little Snake Hill—Britton. Warren: A clump on the Musconetcong near Bloomsbury—Porter; and common in the middle and southern counties.

*Q. bicolor*, Willd. Swamp White Oak.

In low grounds. Burlington: Marlton—H. A. Green; and common in the middle and northern counties.

*Q. phellos*, L. Willow Oak. Pin Oak.

Mercer:—Willis. Monmouth: Keyport—Lockwood; near Long Branch—Leggett. Middlesex: South River—Prof. Cook; New Brunswick—Miss Cook; and common southward.

*Var. pumila*, Pursh.

Salem:—Commons. Ocean:—Wm. Bower.\*

### CATALOGUE OF PLANTS.

221

*B. nigra*, L. River Birch. Red Birch.

Along rivers and lakes. Common throughout the State. Especially abundant along the Delaware and all its tributary streams.

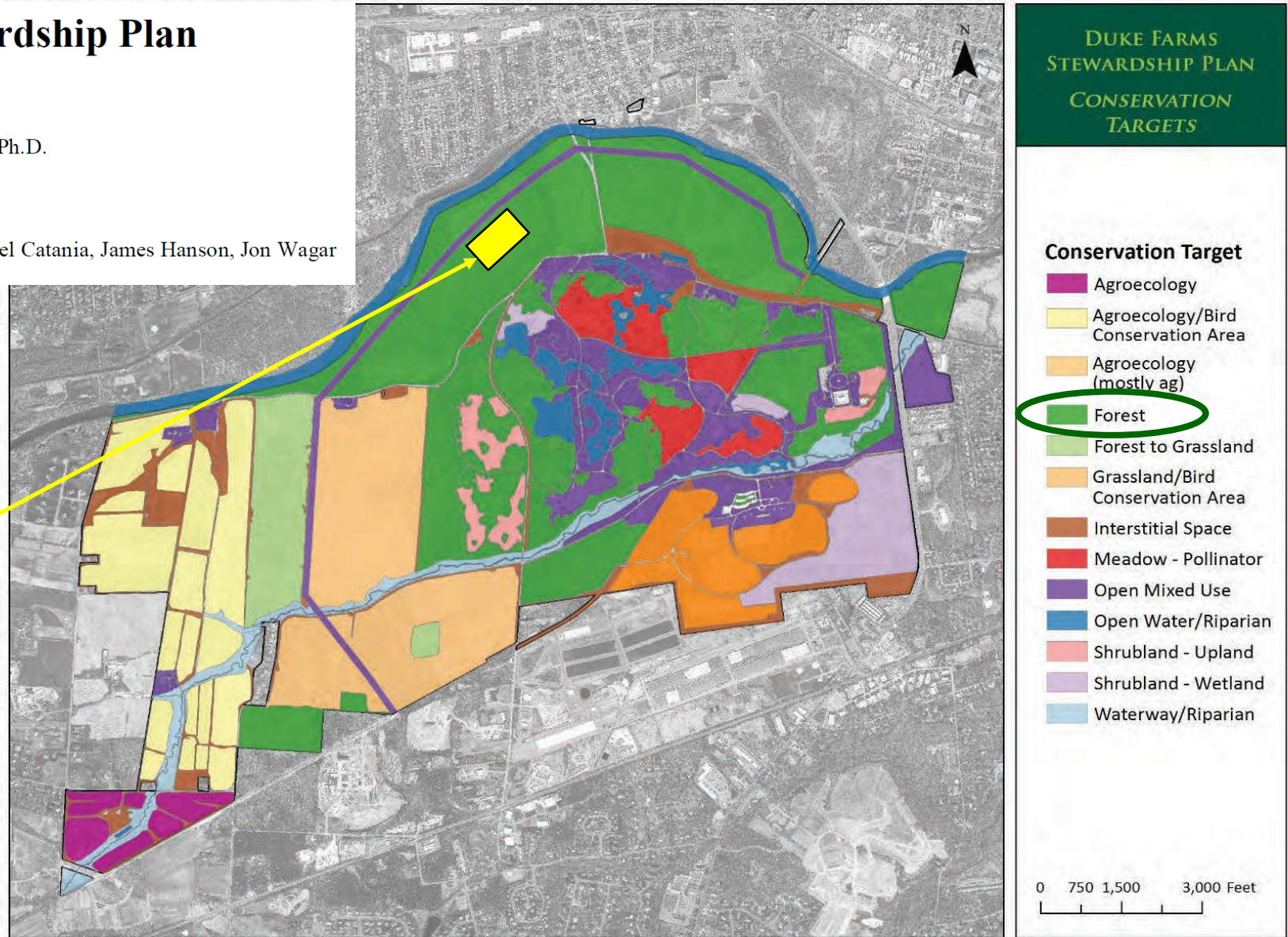
# Duke Farms Land Stewardship Plan

May 2017

Prepared by Michael Van Clef, Ph.D.  
Ecological Solutions, LLC  
&  
Duke Farms Staff

Thomas Almendinger, Charles Barreca, Michael Bellaus, Michael Catania, James Hanson, Jon Wagar

In 2021, a 17.8-acre mitigation plot was planted, which was evaluated to help determine which native plants remain acclimatized to this environmental setting



## Project Scope and Objectives

112 Acres (109 acres of planting; 3 acres of vernal habitat)	Trees will be planted on 10-ft centers and will compose 80% of the planting. Shrubs will be planted on 8-ft centers in dedicated plots and will compose 20% of the planting; all plants will be weed matted and staked
<i>Native Species Planting Plan</i> and <i>Invasive Species Treatment Plan</i>	There are 18 prescribed native tree and 22 prescribed native shrub species designated in the Planting Plan and a vigorous Invasive Species Treatment Plan. Site was enclosed by 16,700 linear feet of deer exclusion fencing
Tree and shrub plant container sizes (3-gallon to 5-gallon containers)	<b>5 percent</b> of the planted trees will be a larger caliper size ( <b>0.75-inch</b> caliper or 7-gallon container); ~475 large caliper trees (primarily pin oaks) found and retained in the fields can be counted toward this percentage

## Project Scope and Objectives

Monitoring Program	Sixty (60) vegetation monitoring plots (1.4% of total acreage), randomly placed within fields, with the number of plots within each field weighted by acreage, and the split between tree and shrub plots weighted by percent composition (approximately 80% and 20%, respectively) of each class. Thirty (30) of these plots will be permanent and will have the same location every year, while thirty (30) will be randomized every year to ensure full representation of the planting area
Monitoring Metrics	<ul style="list-style-type: none"><li>(1) Tree/shrub survivability;</li><li>(2) Stem density;</li><li>(3) Tree height.</li><li>(4) Invasive species percent cover;</li><li>(5) Native vegetation percent cover; and</li></ul>
Stipulated Performance Criteria for every aspect of the project	85% plant survival, 85% beneficial cover with less than 10% invasive species; trees must be an average of 8 feet or higher; vernal pool must contain water for certain periods and be dry during other periods.

## Phase 2b: Construction Scope & Performance Objectives

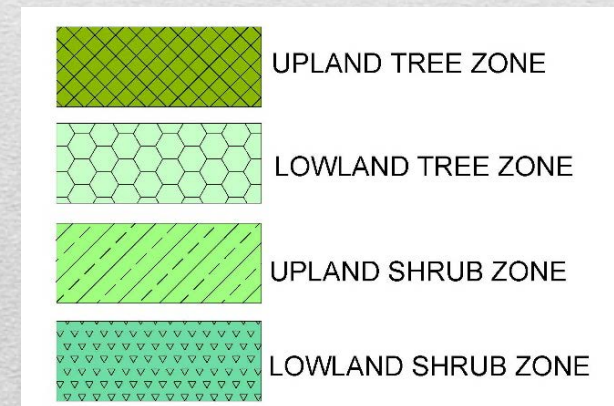
## Project Scope and Objectives

Interim Monitoring Reports	An Annual Monitoring and Maintenance Report due by January 31st of the next calendar year shall (1) summarize monitoring efforts; (2) summarize and provide full detail of monitoring data; (3) evaluate compliance with performance metrics; (4) propose contingency measures (if needed); (5) detail maintenance activities that were performed at the site; and (6) describe any other findings pertinent to the Trustees' understanding of the implementation of the work
Final Monitoring Report	The <i>Final Monitoring Report</i> will summarize all monitoring and maintenance activities, describe compliance with performance criteria, and identify what penalties from the Long-term Stewardship Payment Schedule should be assessed
Site will be maintained and monitored for 5 years per NJDEP permit requirements	A <b>Project Completion Certificate</b> will be issued following Year 5 if all conditions are met upon submittal of a <i>Final Monitoring Report</i>

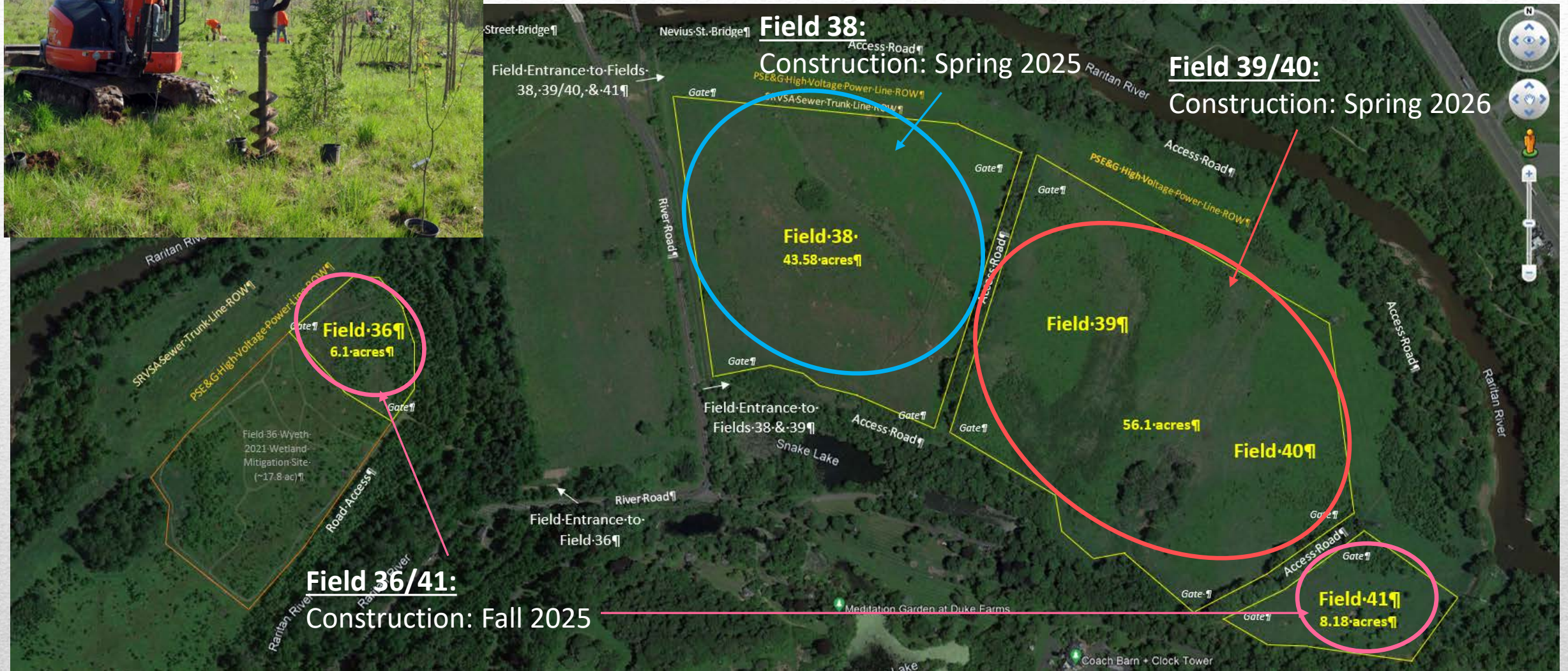
There are additional obligations and activities that take place in Years 6 through 15 (e.g., maintaining the fence)

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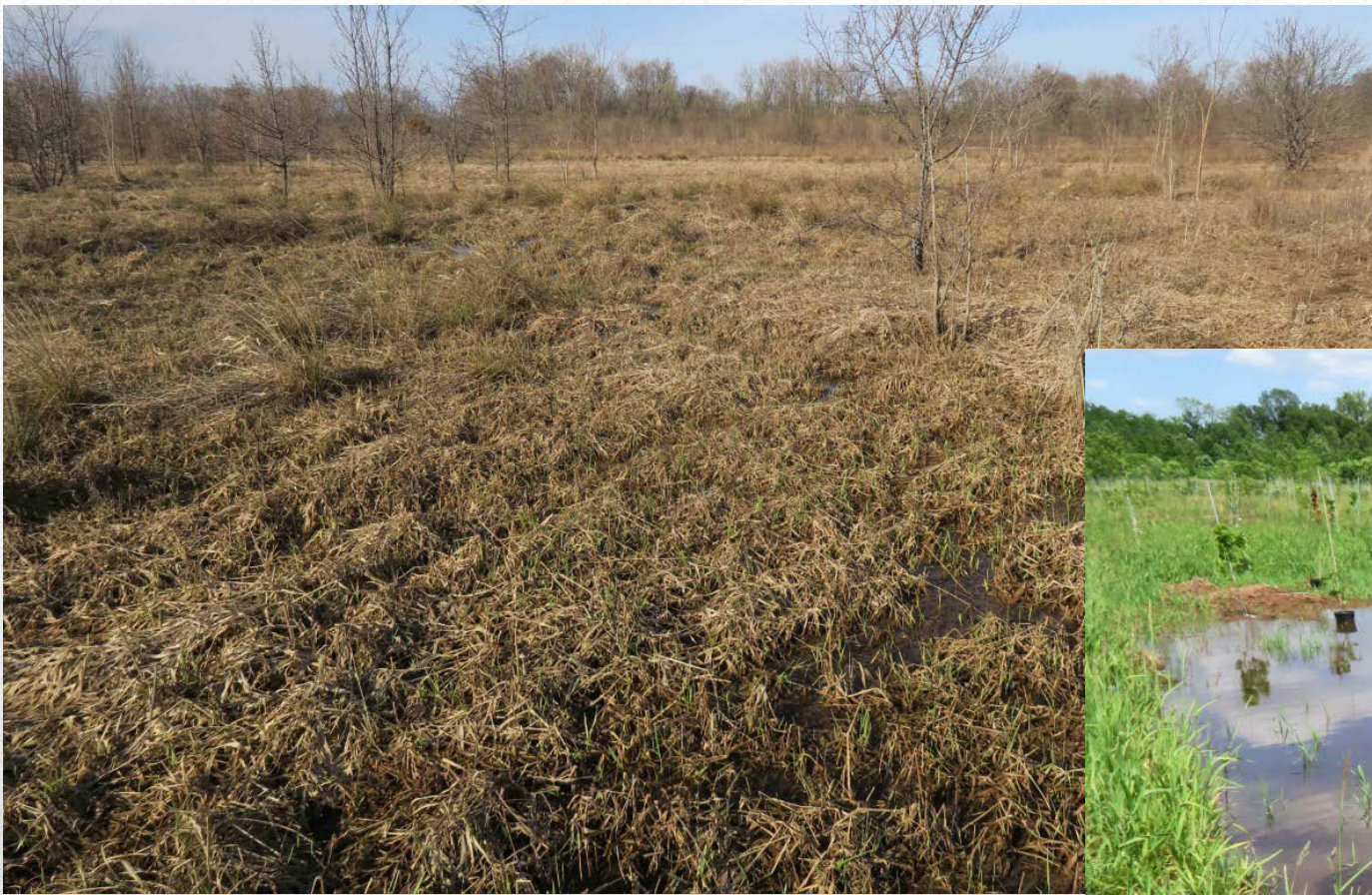
## Phase 2b: Construction Scope & Performance Objectives



# Phase 2b: Forested Floodplain Design Drawing – Field 38



## Phase 2b: Forested Floodplain Proposed Project Sequencing



**Before**

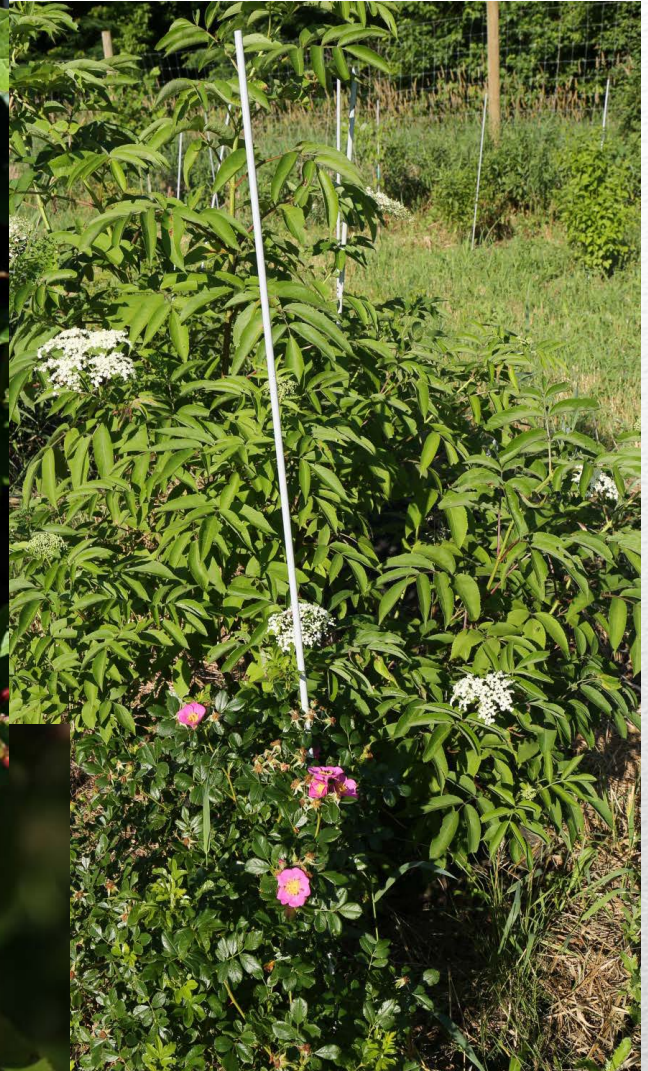


**After**

## Phase 2: Projected Outcomes – Vernal Habitat



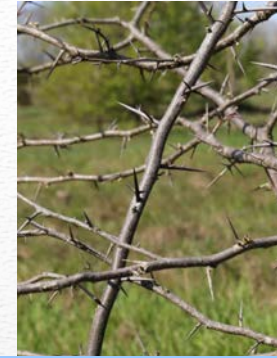
**Before**



**After**



## Phase 2: Projected Outcomes – Shrub Habitat



**Before**



**After**



## Phase 2: Projected Outcomes – Forested Floodplain Habitat

- Content development of proposed interpretative signs along a newly-constructed trail along the Raritan River
- Assumption of perimeter fence maintenance in Years 6-15
- Allowing regulatory agency access to the site for the Year 1-15+ monitoring period
- Control of Callery pear and other invasives in Lowlands hedgerows and along River Road



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Questions?